

NASA SPoRT Training: GPM Precip Products

Anita LeRoy

NASA Short-term Prediction Research and Transition (SPoRT) Center / UAH
Huntsville, Alabama

Alaska Fire Science Consortium

<ftp://geo.nsstc.nasa.gov/SPoRT/people/gstano/AFSC/>

Fairbanks, Alaska

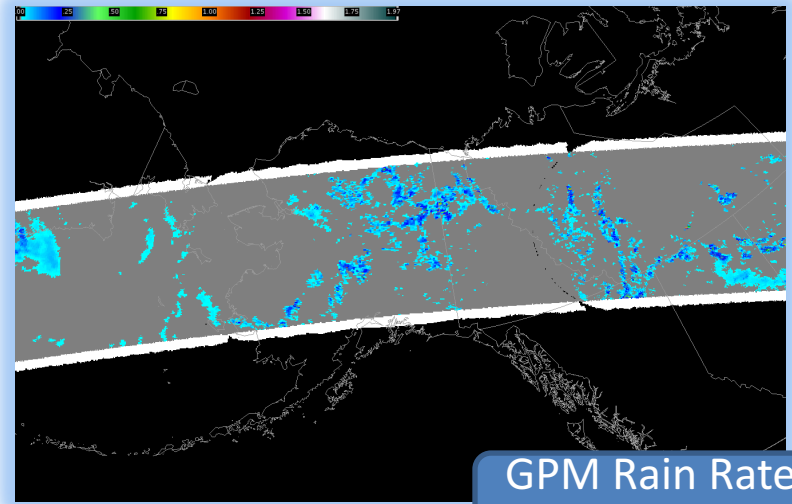
3 April 2017



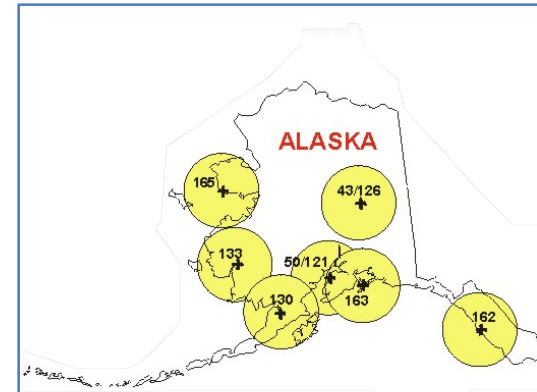
Introduction

Training Objectives

- Describe key features about GPM swath rain rates and IMERG and how rain rates are derived
- Identify where you should have high/low confidence in the GPM products
- Apply GPM products in operations with complementary products



GPM Rain Rate
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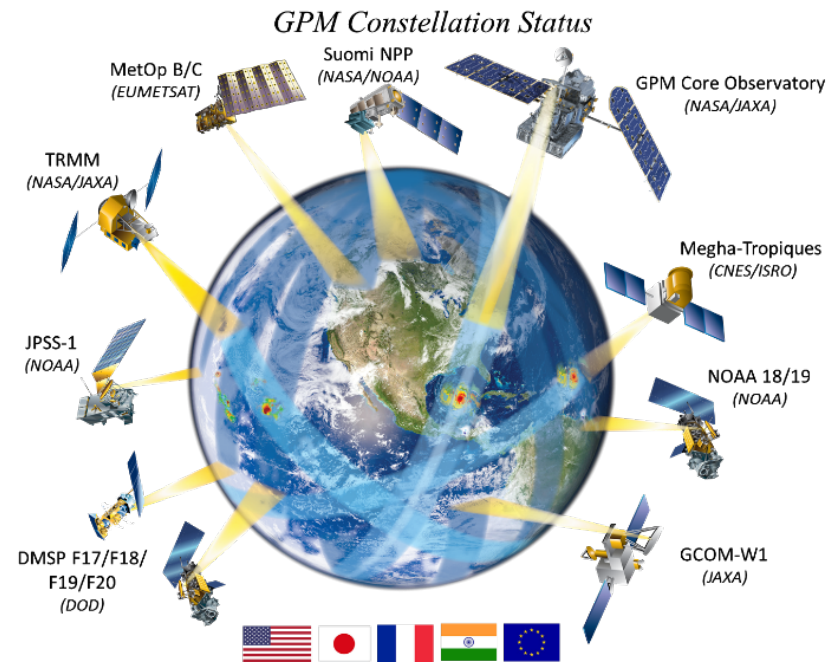


NASA GPM Mission Background

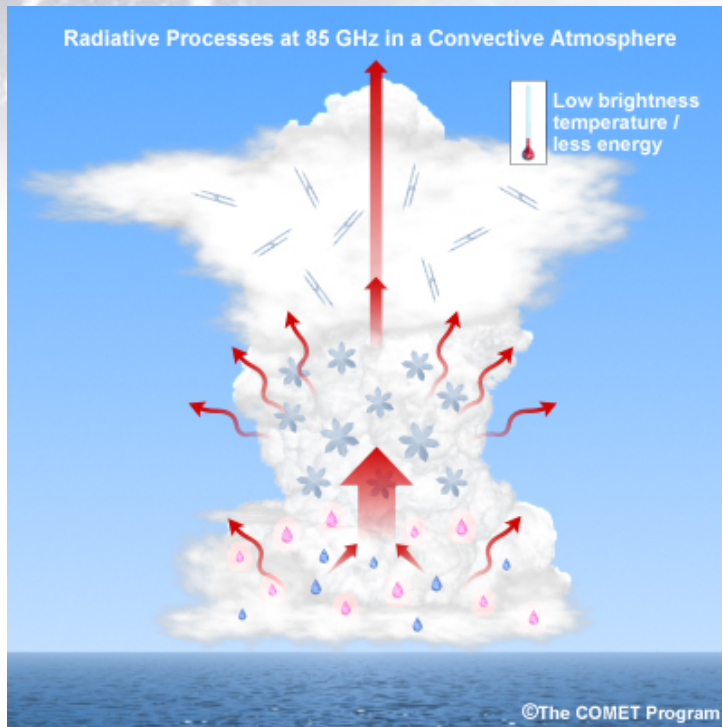
- **NASA GPM Mission purpose:**
 - observe global rainfall;
 - improve forecasts through assimilation and instantaneous precip info;
 - study the water cycle, water resources, precip microphysics, extreme weather events, climate sensitivity.
- **GPM Constellation:** international consortium of research and operational satellites that estimate rain and snow globally

Rain Rates from a Constellation

- Global coverage from several different satellites
- Temporal resolution varies and can be as high as several overpasses an hour
- Spatial resolution varies based on instruments and frequencies



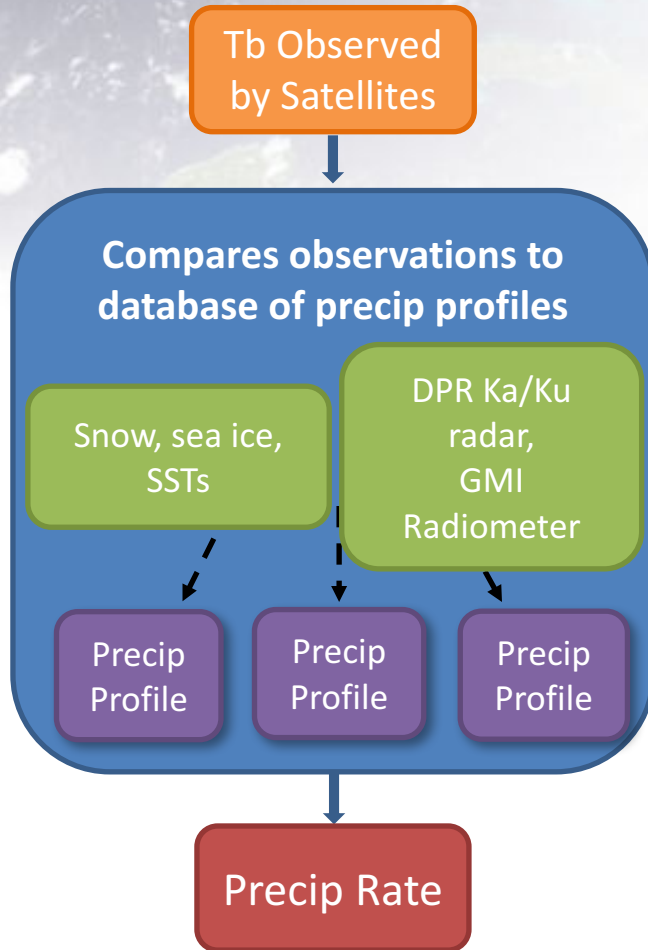
How are Passive Microwave Rain Rates (RRs) Derived



Imagery from the COMET Program

- Rain rates inferred from brightness temperatures
- Lower frequency channels observe emission from liquid hydrometeors
 - Works best over oceans
 - Cannot easily distinguish cloud emissions from land emissions
- High frequency channels observe scattering off of ice in clouds
 - Works best for ice process (convection)
 - Preferred for land

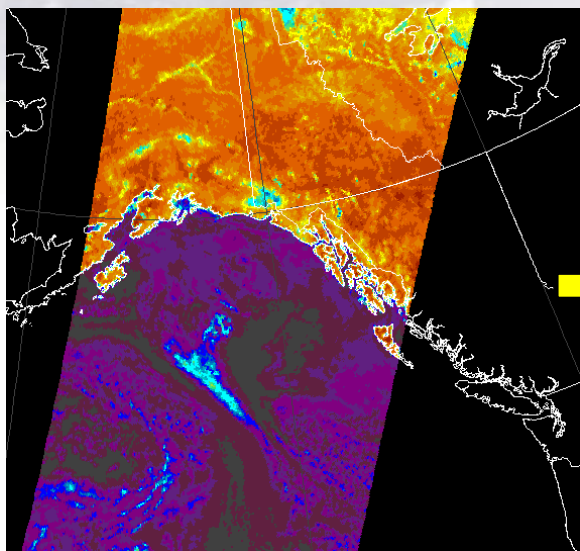
How are RRs Derived



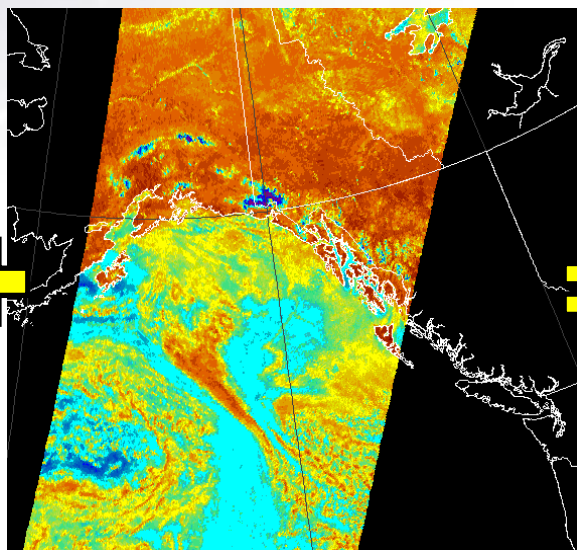
- Database incorporates GMI, DPR, model and surface obs
- Observes brightness temps (Tbs) using Constellation of passive microwave instruments
- Compares obs to database of observed precip profiles and associated Tbs from GPM core instruments to determine rain rates

Passive Microwave Rain Rates

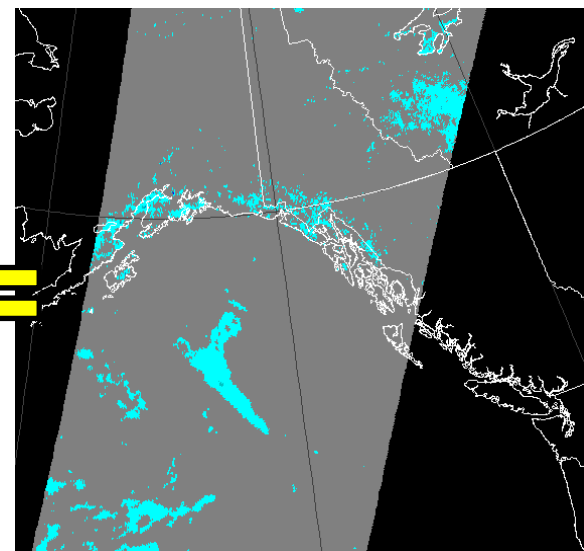
- Take advantage of unique capabilities
- Derive a rain rate product
 - SPoRT using data derived from the Global Precipitation Mission (GPM) science team
- GPM Microwave Imager includes higher frequencies for ice content
- Channel trade-offs
 - Lower frequency: Better cloud penetration
 - Higher frequency: Better resolution



37 GHz: Intensity and areal extent and at lower levels



89 GHz: Intensity and identifying storms with high ice content

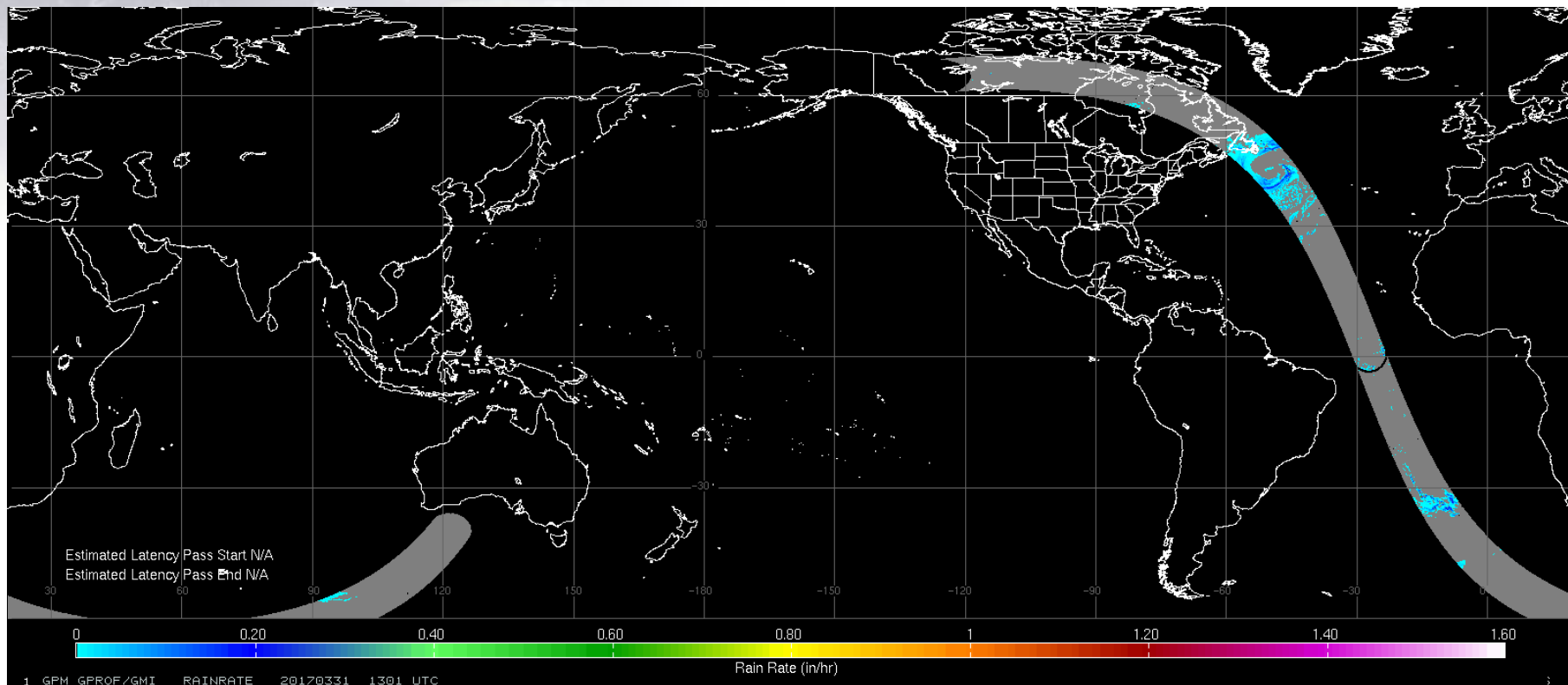


Rain Rate: Inches per hour

Quiz

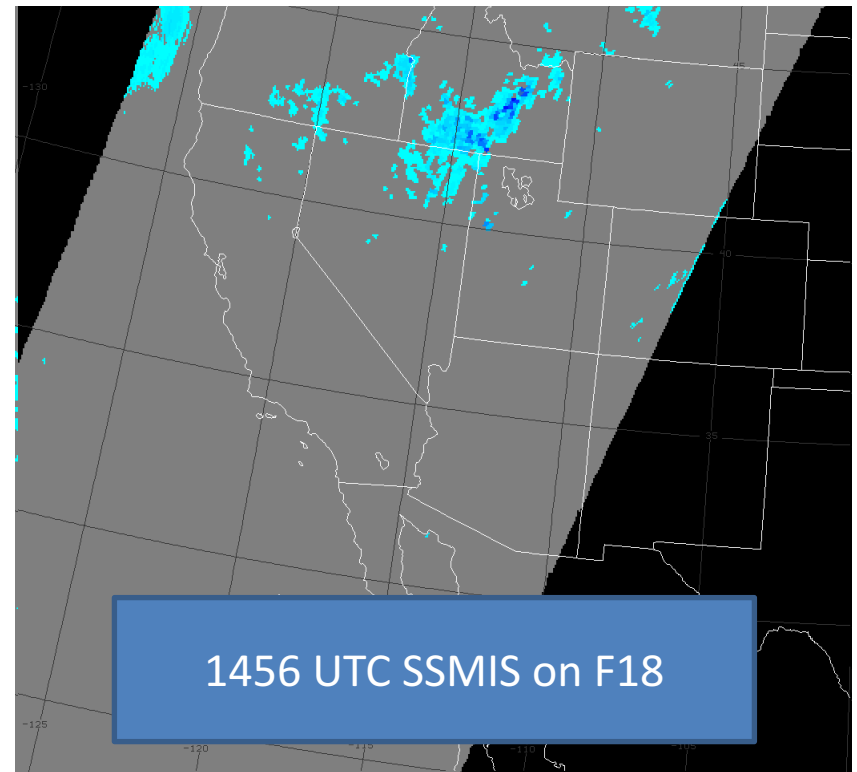
- GPM rain rates...
 - Come from a number of intercalibrated passive microwave instruments on different satellites
 - Were designed for research
 - Are derived by comparing observations to an existing database of precip profiles

GPM Swath Rain Rate Product



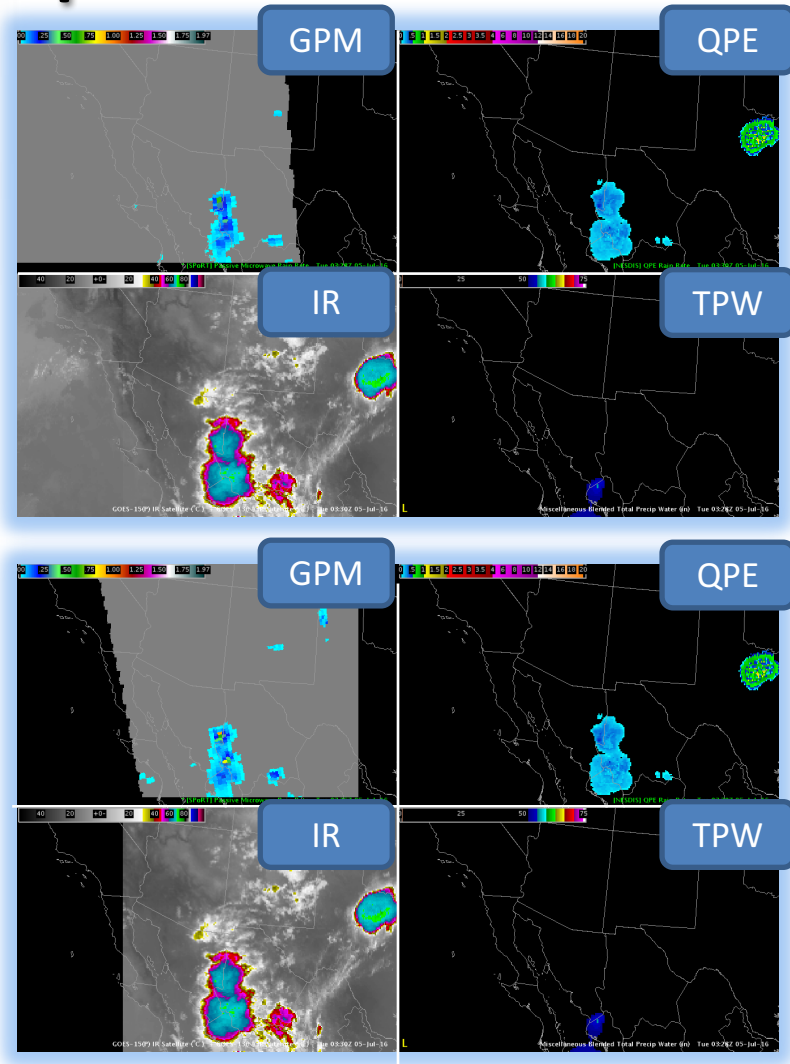
Product Details - GPM Swaths

- Temporal and spatial resolution vary by instrument
- Coverage
- Access the imagery
 - Satellite menu in AWIPS
 - NASA-SPoRT's Real Time Page:
<https://weather.msfc.nasa.gov/sport/>
 - NASA Worldview:
<https://worldview.earthdata.nasa.gov/>



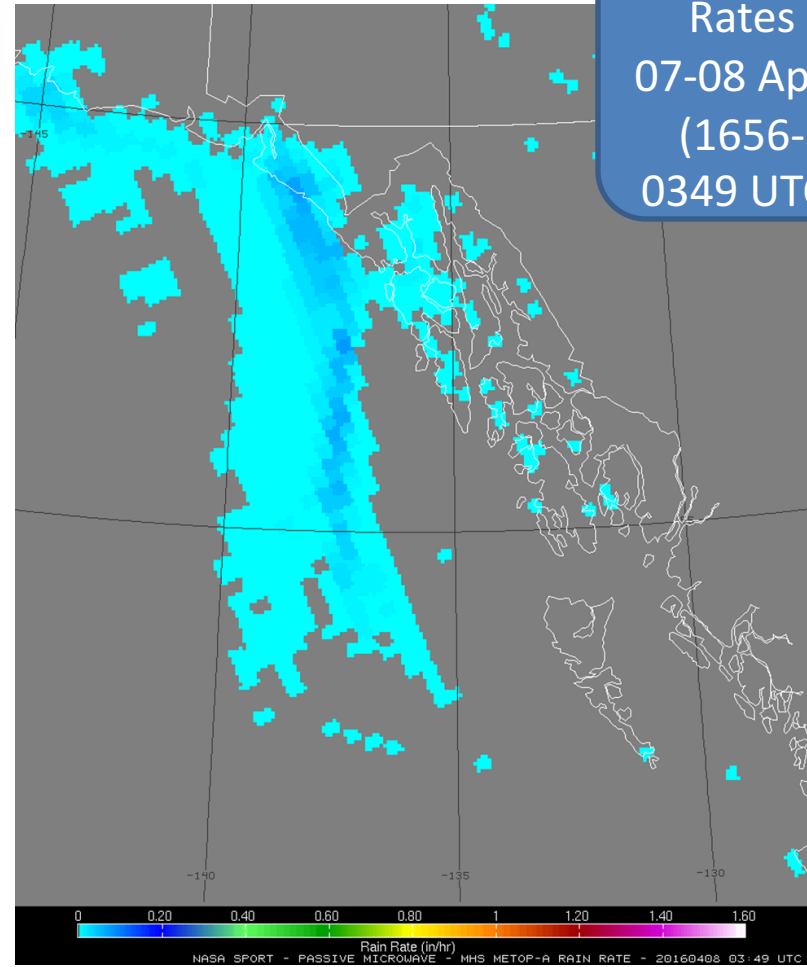
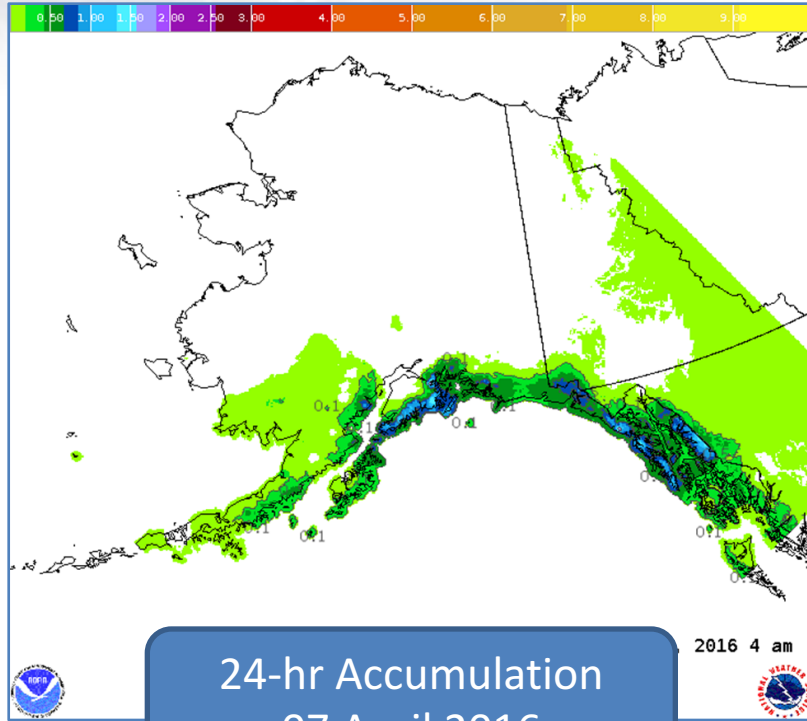
Utility in Operations

- Provides precip info in data-void regions and offshore
 - Where radar/gauges are unavailable or need supplementation
- Use in conjunction with IR to identify most intense convection



Product Application

Offshore precip in AJK
area of responsibility



- <https://weather.msfc.nasa.gov/sport/>

- Passive Microwave (GPM Constellation) - Regional Rain Rate (Metop-A)
Mar. 29, 2017 - 18:12 UTC

• Review [details](#) of the Passive Microwave products

Select an orbit:
Mar. 29, 2017 - 18:12 UTC - H4G

Zoom to a region:
Alaska Region

• Previous Next

Global
37 CH2 H 88 CH4 V 88 CH4 RGR
37 CH2 V 88 CH4 V 88 CH4 RGR
37 CH2 H 88 CH4 V 88 CH4 RGR
37 CH2 V 88 CH4 V 88 CH4 RGR

Regional
37 CH2 H 88 CH4 V 88 CH4 RGR
37 CH2 V 88 CH4 V 88 CH4 RGR
37 CH2 H 88 CH4 V 88 CH4 RGR
37 CH2 V 88 CH4 V 88 CH4 RGR

Legend
Rain Rate
Time of Day

Animate This Product

0 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60

Rain Rate (mm)

Light Spot - PASSIVE MICROWAVE - HHS METOP-A RAIN RATE - 20170329 18 12 UTC

F: Use the Previous/Next buttons to find an orbit over your region...THEN select “Rain Rate” in the “Regional” section

Access Swath Rain Rates-Woldview

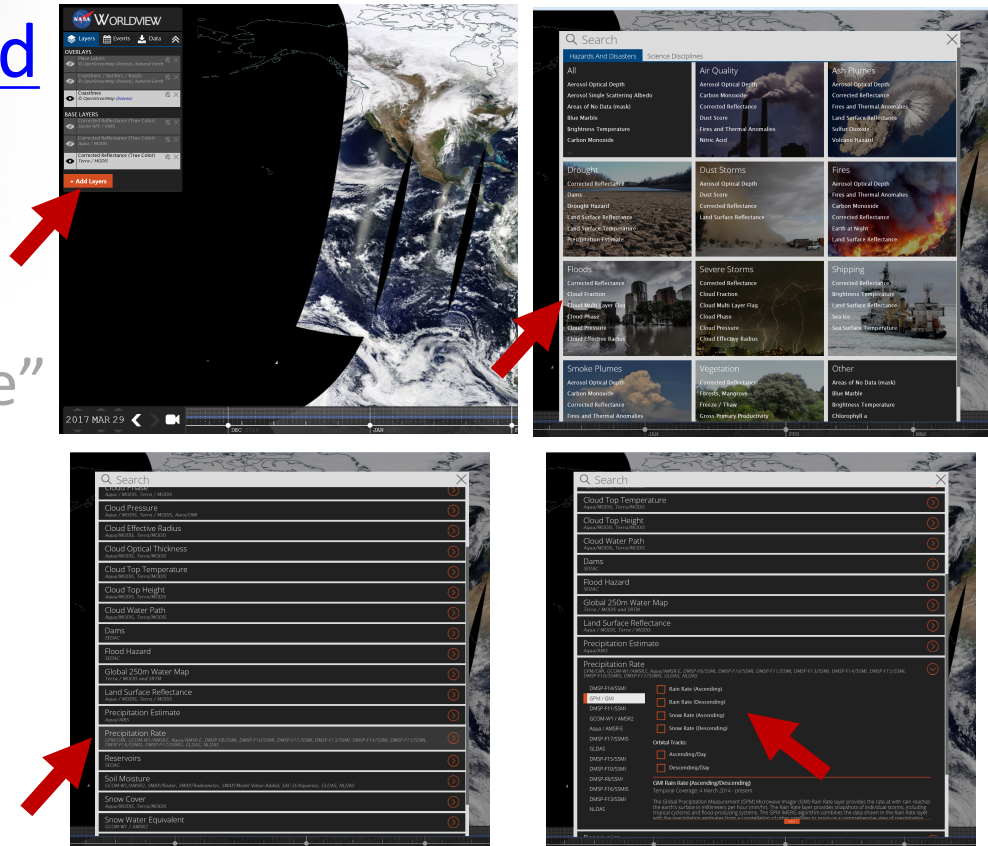
<https://worldview.earthdata.nasa.gov/>

- Click “Add Layer”
 - Select “Floods”
 - Select “Precipitation Rate”
 - Select as many data sources as you want.
- Want NRT? Use one of these:

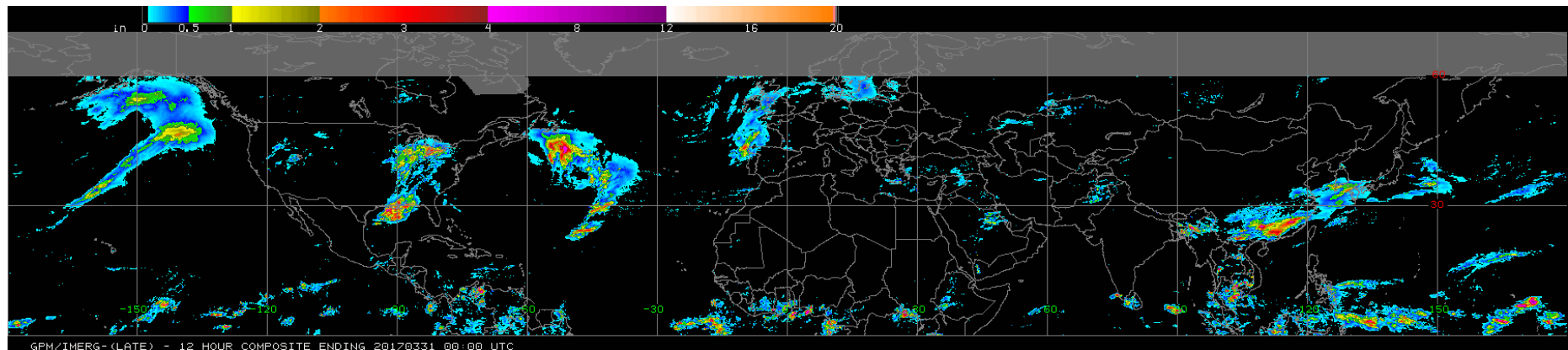
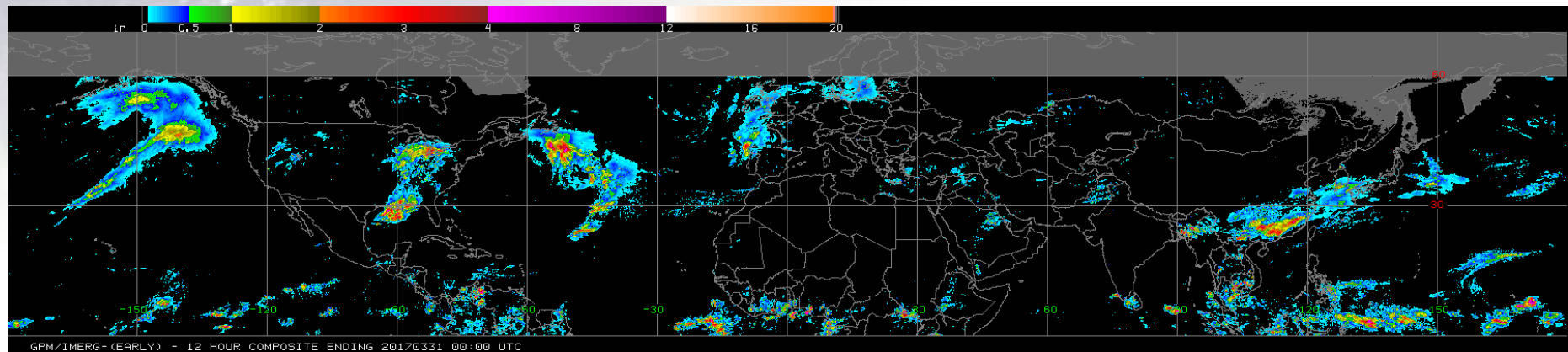
- GPM/GMI
- GCOM-W1/AMSR2
- DMSP-F17/SSMIS
- DMSP-F16/SSMIS

- Select date

transitioning unique NASA data and research technologies to operations



GPM IMERG Products: Early and Late



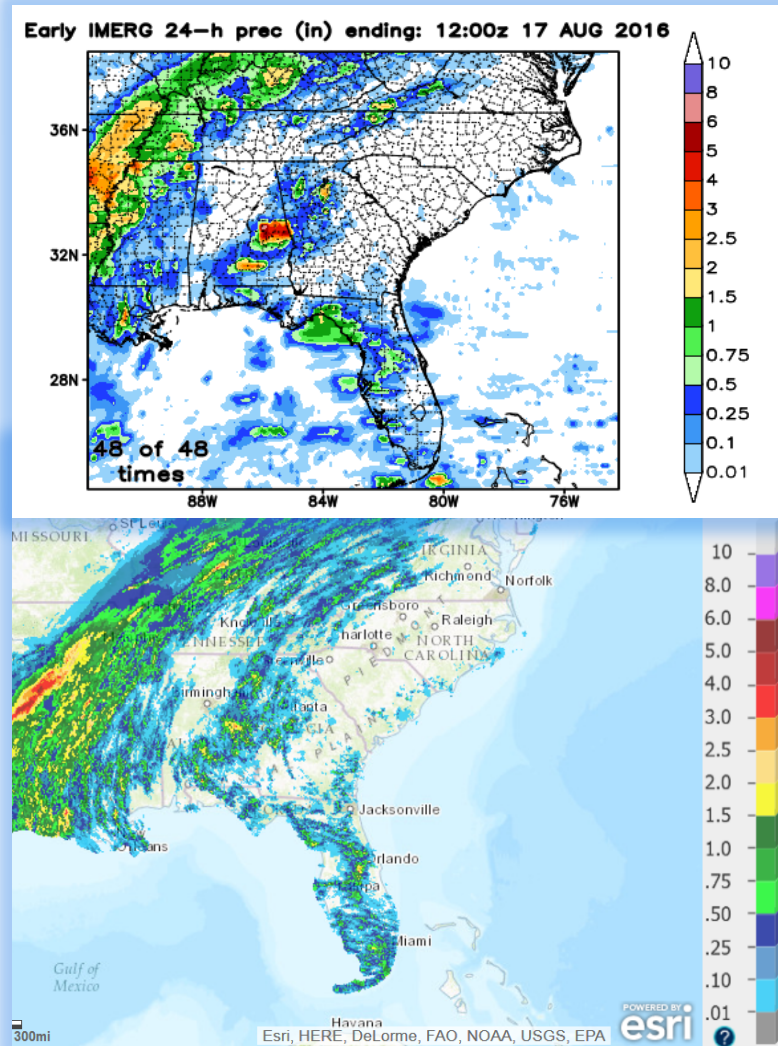
Products

- 3 different gridded data products
 - “early” 4+ hour latency and is half-hourly
 - “late” 8+ hour latency and is half-hourly
 - “final” research/climate product with a two month latency; produced monthly
- 0.1 deg spatial resolution
- 60N-60S (global product forthcoming)

Application Example

IMERG can be used to:

- observe precip in data-void regions
- accumulate precip in synoptically significant time periods
- supplement existing data



Product Details - IMERG

- First algorithm to fuse techniques from TMPA, CMORPH-KF, and PERSIANN-CCS
 - CMORPH-KF uses PMW instantaneous RR looking forward and backward in time and space
 - CMORPH-KF fills in with IR if PMW is older than 90 minutes
 - PERSIANN-CCS uses IR (Tb-RR relationship) in a neural networking scheme for Cloud Classification

Early and Late Products

- Same input data in both products
 - **Passive microwave** – derived rain rates from several satellites
 - GPM DPR+GMI (merged **passive MW/radar**)
 - **IR data** (GOES, NPP CrIS, AIRS, Meteosat, MTSat)
- Processing is different in the Early and Late products
 - Forward morphing in Early product
 - Forward/Backward morphing in Late product
 - Result: **IR data more prevalent in Early product**

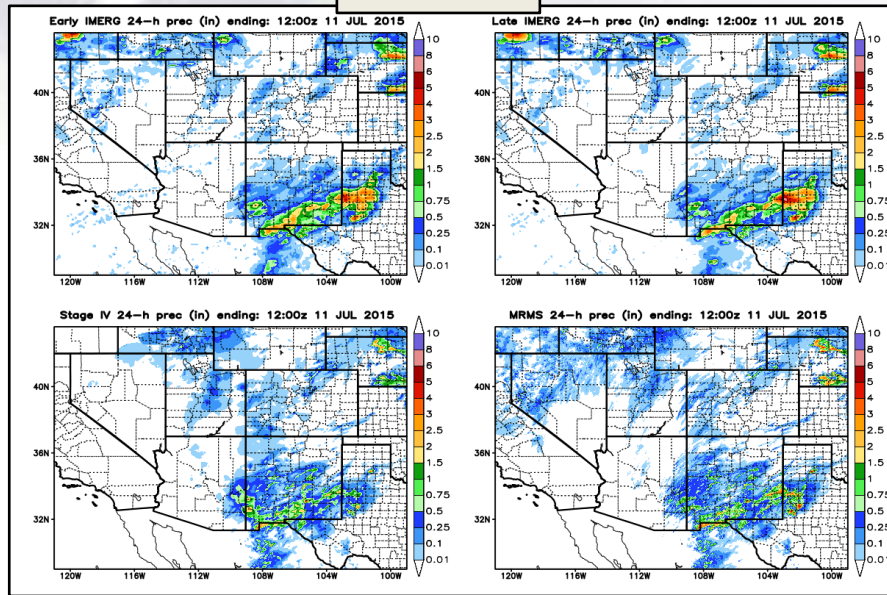
Final Product

- Uses monthly gauge data
 - Modified spherical Shepherd scheme:
 - Result: **accounts for distance and direction of propagation of precip**
 - **Gauge data calibrates Early and Late, but Early and Late do not have gauge data in them**

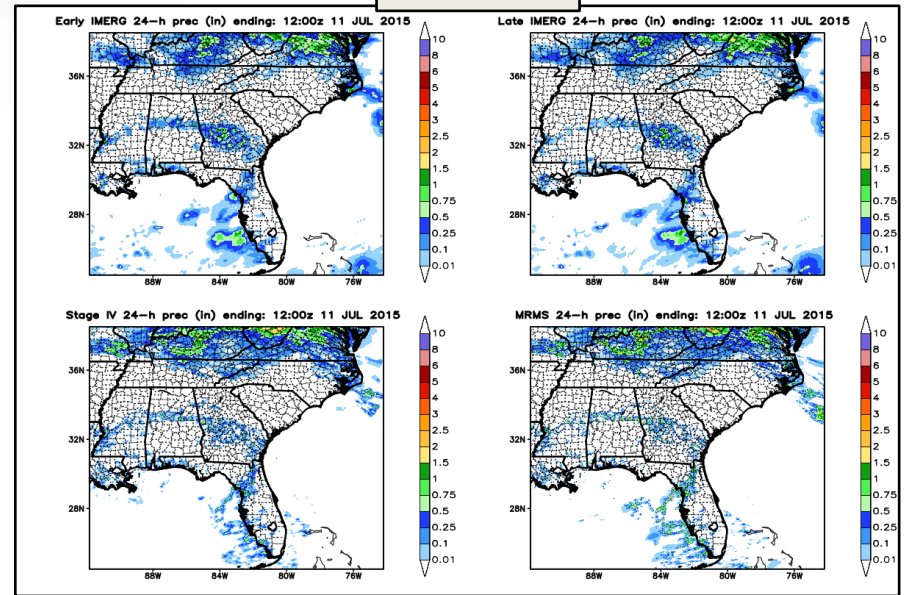
Comparisons

- SPoRT working on study to compare Early, Late, Stage IV, and MRMS

SW US

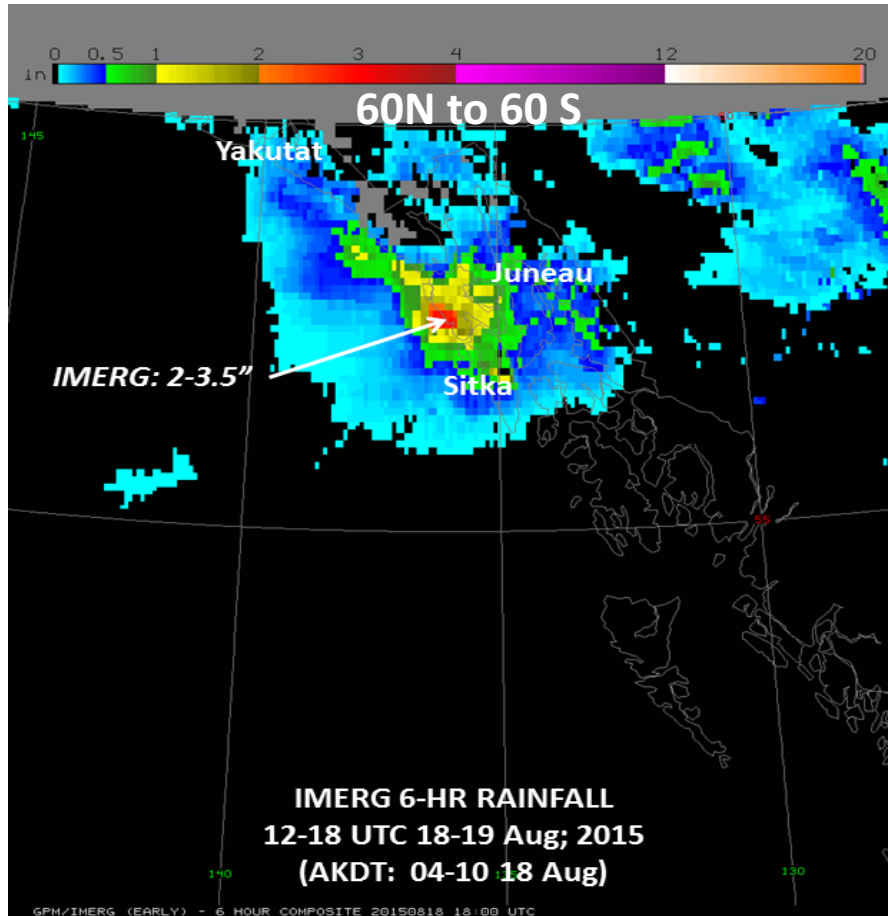


SE US



Transition of L3 IMERG Data to Forecasters

Image by Aaron Jacobs (NWS/Senior Surface Hydrologist, Juneau WFO)



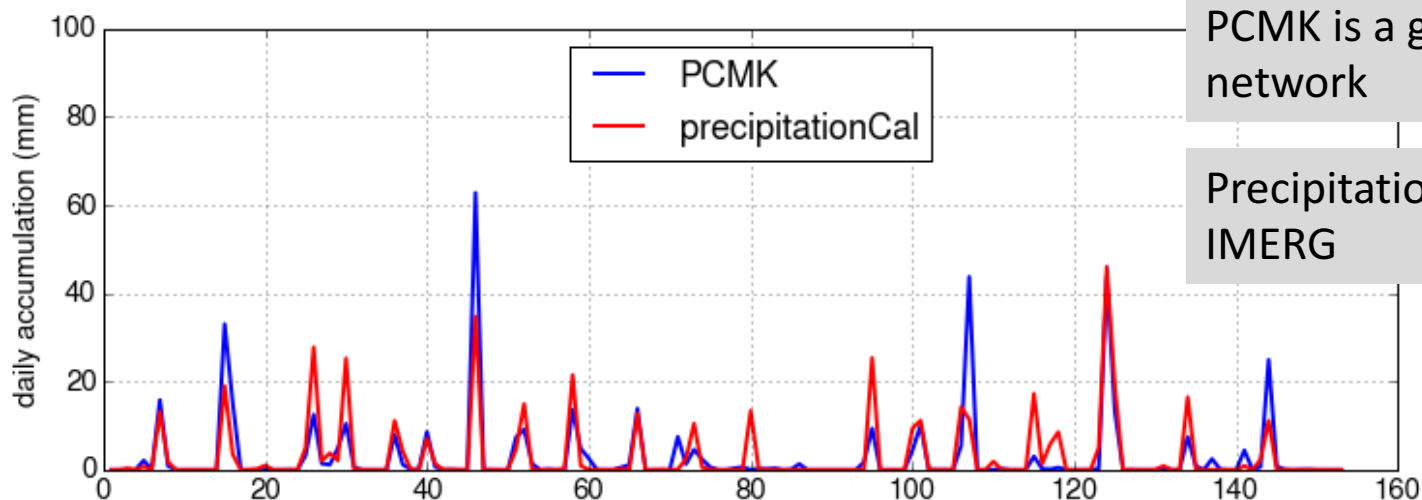
- Due to latency, most useful for hydrologic applications to pinpoint areas of heaviest rainfall outside of radar coverage
- Product used for post-event analysis of landslide event in the Juneau area on 18 August
- Also used by Albuquerque WFO to analyze flash flood event in July

James Poulson / The Daily Sitka Sentinel AP



Validation

- So far, validation has occurred over CONUS in radar-covered locations (i.e., not complex terrain) during spring and summer (i.e., predominantly convection)
- Compares well to MRMS



PCMK is a gauge network

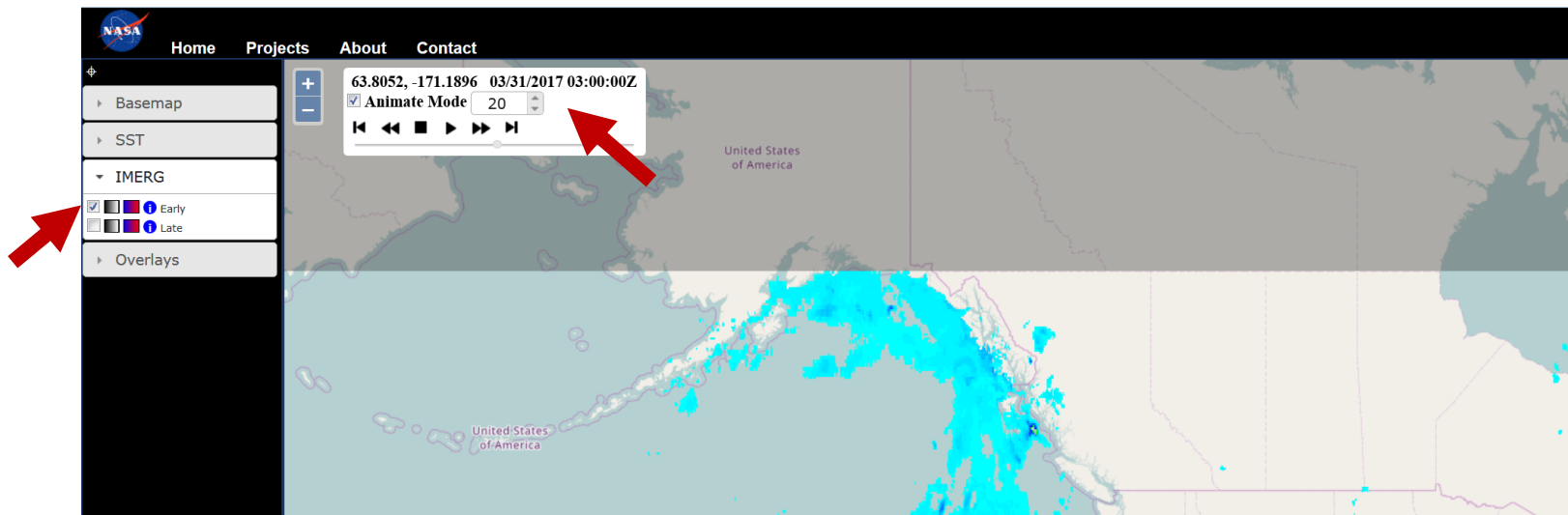
PrecipitationCal is IMERG

Access IMERG Rain Rates and Quiz

- <https://weather.msfc.nasa.gov/sport/>
 - Find “Global Precipitation Measurement” under “Real-Time Data” menu
 - Go to “IMERG” and “Early”
- T/F: Alaska is really well represented in the IMERG rain rates
- F: Currently, the IMERG domain is only from 60N-60S...but you can see incoming precip offshore

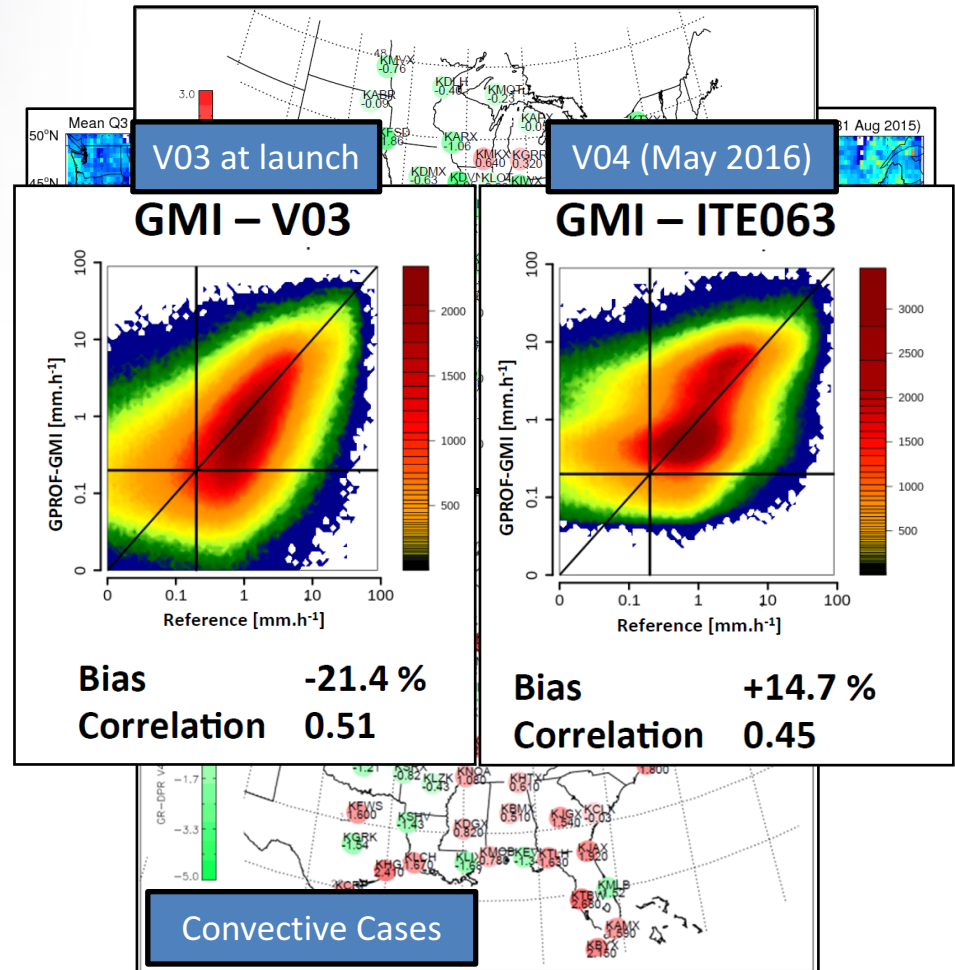
Access IMERG via SPoRT WMS

- <https://weather.msfc.nasa.gov/viewer/viewer.html?config=akfireweather>
- Can toggle products on and off from the pane on the left
- Animation mode...animate one product at a time



Validation

- WSR-88D vs DPR
 - DPR attenuates and underestimates convection
 - Stratiform cases match sources to within 1 dB
- Version 03 vs Version 04
 - V04 compares well with MRMS
 - V04 slight high bias but depends on precip mode
 - Light rain and heavy rain: overestimated
 - High lats: possible underestimates





Strengths

- Constellation improves spatial coverage and temporal resolution
- High frequency GMI channels better capture light rain events than predecessors
- PMW sees “through the clouds”, unlike IR which uses cloud top temps

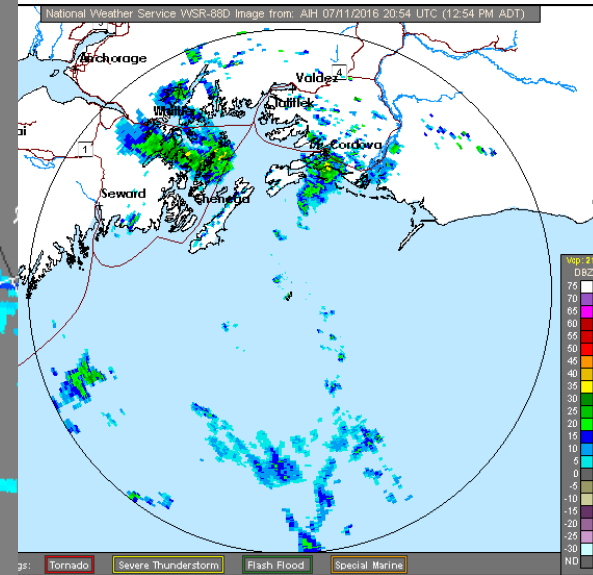
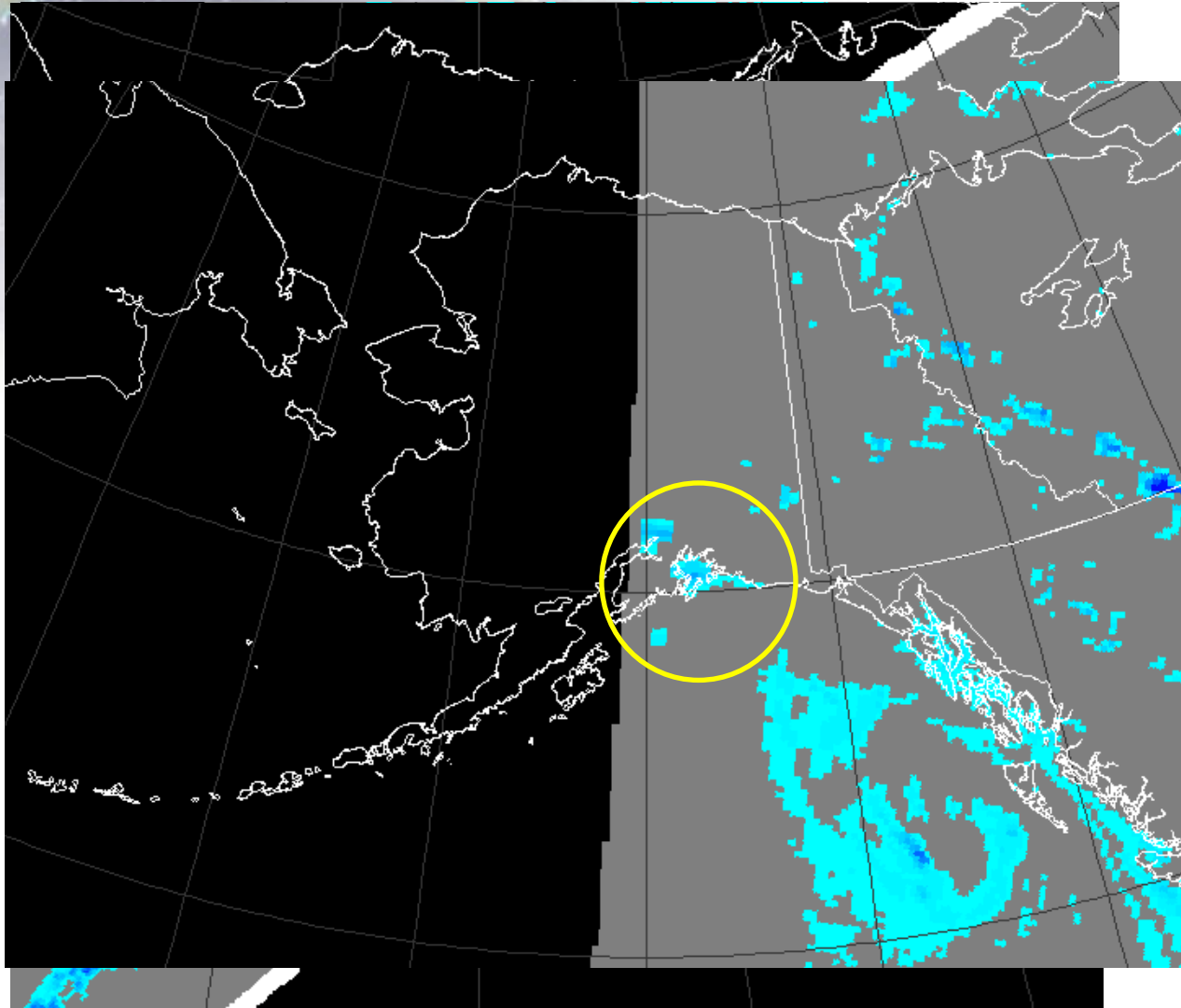
Limitations-GPM Swath Rain Rates

- Inconsistent spatial resolution and temporal frequency among instruments
- Decreased coverage and frequency equatorward
- Latency of 1+ hours
- PMW retrievals have continuity problems along coastlines

Limitations-IMERG Rain Rates

- Currently limited to 60N – 60S
- Latency of 4+ hours (Early Product) and 8+ hours (Late Product)

Quiz



Conclusions

GPM Rain Rate Products...

- Are from a constellation of satellites;
- Can supplement existing data;
- Are utilized in data-void and offshore regions.

Additional resources:

[NASA-SPoRT](#)

[COMET training](#)

[GPM Mission Page](#)

Anita.LeRoy@nasa.gov



transitioning unique NASA data and research technologies to operations

